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GHG and cattle farming: CO-assessing the emissions and economic performances in Italy

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ABSTRACT

In the last decades, the offer of animal products is more and more increasing especially in developing countries due to growing food demand and needs. The activities of the livestock sector impact on climate change with several emissions in particular, Methane (44%), Carbon dioxide (27%) and Nitrous oxide (29%). Cattle emits the highest, about 65% of the livestock production emissions; indeed feed processing and production and enteric fermentation from ruminants are the two major sources of emissions, contributing to 45% and 39% of total emissions respectively. On product-basis, milk from cows and beef are in charge to emit the most emissions. Cattle-farming for dairy and beef production is one of the main most important agricultural activities in Italy. The link between cattle emissions and economic performance is the issue that here has been addressed at the light of the societal challenge increasingly based upon bio-based economies. There are few studies regarding the GHG emissions associated with the cattle production and economic performances. Therefore, the objective of this study is to classify the cattle farm emissions respect to the economic performance variables of Italian cattle farming sector and to classify segment of firms in clusters: for these aims a CHAID decision-tree algorithm and a two-stage method of clustering was carried out. Decisional trees and cluster analysis highlight the significative links between farm emission and profitable variables. Results show the GHG emissions increase with the increase of the production amount, only if the firm handling is not efficient: indeed virtuous cattle farms present a regimented and planned resources management allowing low GHG emissions. This analysis can shed some light on the efforts for reducing GHG emissions deriving from cattle farming, and so following bio-economy pathways to actually equitable, sustainable, post fossil carbon societies.

1. Introduction

In the European Union, the agricultural sector contributes approximately 10% to the total greenhouse gas (GHG) emissions (Ingrao et al., 2015). Cattle farming is one of the most important agricultural activities in those European countries. This primary sector contributes to around 12.9% of calories and 27.9% of protein consumed globally (FAO, 2011). Animals convert carbon and nitrogen from feeds (silage, imported forages, and home-grown forages) into milk and meat. According to Gerber et al. (2016) global consumption of livestock products is growing rapidly, especially in developing countries, due to the growth population and increasing demand of food. To meet the rising demand, the livestock production shift from traditional extensive and mixed systems to industrial farming systems (Bouwman et al., 2005; Galloway et al., 2007). In the last few decades agriculture and livestock production have produced many global environmental issues, such as deforestation, climate change, water pollution and biodiversity loss. At global level, emissions from ruminant animal husbandry are principally caused by enteric fermentation and manure management, and they are equal to 39% of the total agricultural emissions. Emissions from grassland soils contribute to 17% on the total emissions. Assuming that all ruminant animal husbandry are farmed on grassland soils, the overall emissions from the ruminant livestock sector can be estimated at 56% of the total agricultural emissions (Gerber et al., 2013). The most important associated GHG emission is methane (CH_4), due to enteric fermentation. Emissions of nitrous dioxide (NO_2) in a small amount may occur from the rumen. CH_4 emissions from manure management often are smaller than enteric emissions, and are caused by different animal management operations, where manure is handled in liquid-based

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systems. NO_2 emissions from manure management vary significantly between the types of management system used. Carbon dioxide (CO_2) emissions are not estimated because annual net CO_2 emissions are assumed to be zero considering that the CO_2 photosynthesized by plants is returned to the atmosphere as respired CO_2. (Dong et al., 2006). Silage feeding involves the use of fuel operated machinery, which leads to direct carbon dioxide and nitrous oxide emissions. Agriculture today must be environmentally and ecologically sound and aligned with public values, e.g. positive landscape image and appropriate animal welfare (Steinfeld et al., 2006). Reducing GHG deriving from cattle farming can occur by choosing to rear animals with an improved genetically based performance: producing milk with higher protein content and at the same time reduced fat content emits less GHG into the environment (Podkówka et al., 2015). Furthermore, results demonstrate that the main element contributing to reduce emissions is the high productivity, that is a comprehensible outcome as the carbon footprint is related to the unit of product. The GHG production increases in absolute terms with the increase of the production amount, but since the reference unit is compared to the product amount, higher is the production efficiency, more you reduce the impacts, since the gases produced are distributed in a greater amount of product (Podkówka et al., 2015; Italian Ministry of Agriculture, Food and Forestry, 2010). Considering that the intensification of livestock production has led to environmental burdens, the study is aimed to co-assess the environmental impacts and economic performances of Italian cattle farming systems based on farm data. The co-assess analysis is an efficient tool for ecological weak-point analyses for farmers and advisors as well as for politicians creating agro-environmental programs. Efficient measures can be derived to establish an environmentally sound agricultural production system. (Haas et al., 2001). In order to address the analyzed problem, data analysis has been performed with the following objectivise: to verify the possibility to classify the farm emission respect to the predictor variables and to identify segments of farms who showed similar values for economics variables. In this regard, the authors believe that the study provide interesting insights, especially as the relationship between environmental impacts and economic performances, as well as considerations and suggestions that can be of help for further research development and improvement.

The remainder of the work is as follows: firstly a literature review on the link between bioeconomy and agriculture is drawn; then, the paper focuses on the livestock sector in Italy. Materials and methods are presented; then result and discussions show insights deriving from the analysis. Finally, conclusions close the paper.

2. Bioeconomy and agriculture

A more and more sharing vision stress the sustainability concept as an intrinsic characteristic of the bioeconomy that should be in turn approached in a more trans-disciplinary way (Pfau et al., 2014). Furthermore, the definitions of the bioeconomy are changing and vary depending on the involved actors and sectors, and on innovations that drive efforts on sustainable development of the bioeconomy (McCormick and Kautto, 2013). The Bioeconomy can became crucial for the primary production, health and the environment (Philippidis et al., 2014) by means of "ecology of scale" computing the energy savings related to the enterprises of production and processing of larger or SMEs (Contò et al., 2015). So in turn this can be entails a business management improvement that follow a knowledge exploiting strategy (Giacomarra et al., 2016; Bresciani et al., 2015). In fact, providing a diagnostic tool to farmers general performance of the farm might improve sustainability and efficiency (Paracchini et al., 2015). Then, key strategic objectives of the new CAP are focused on eco-sustainability concept: sustainable food production, crop diversification and the sustainable management of resources (Solazzo et al., 2015). In addition, the EU Commission has launched and adopted on 13 February 2012 a Bioeconomy Strategy aimed to three phillars/key aspects:

- increasing new technologies and processes for the bioeconomy;
- developing markets and competitiveness in bioeconomy sectors;
- creating collaboration between policymakers and stakeholders.

The bioeconomy can offered the chance to face these challenges and at the same time can advance the transition from a waste economy to an economy based on renewable resources and sustainable consumption. The concept of the bioeconomy encompasses all sectors of the economy that produce, work and process, use, and trade with renewable resources, and it is thus also resource-efficient productive system (National bioeconomy policy strategy, 2014). The growing bio-economy will boast a greening effect upon agricultural, horticultural, food and feed supply chains, and in sustainable management of all. Different EU programmes and instruments including the Common Agricultural Policy ensure a coherent approach to the bioeconomy that proposes to face challenges as increasing populations that must be fed, depletion of natural resources and climate change.

In particular, climate changes are increasingly taking place as a result of the increasing atmospheric concentrations of carbon dioxide and other greenhouse gases (ibidem): air pollution is a serious element in environmental damage, mainly caused by anthropogenic factors (Gallo et al., 2014). Agriculture is acknowledged as a great contributor to global GHGs emissions due to lacking efficient management of the resources involved (Pellegrini et al., 2016).

In the last decades, the offer of animal products will also have to increase especially in developing countries due to the aim to meet the predicted growth in world population and increasing food demand and needs (Cerri et al., 2016). On product-basis, milk from cows and beef are in charge to emit the most emissions, contributing 20% and 41% of the sector's total greenhouse gas (GHG) outputs respectively (Sarkwa et al., 2016). Because of these significant and serious issues, the beef cattle industry is under increasing pressure to reduce production or implement technological changes (Ruviaro et al., 2015). Furthermore, results demonstrate that the main element contributing to increase emissions is the high productivity, that is a comprehensible outcome as the carbon footprint is related to the unit of product.

The GHG production increases in absolute terms with the increase of the production amount, but since the reference unit is compared to the product amount, higher is the production efficiency, more you reduce the impacts, since the gases produced are distributed in a greater amount of product (Podkówka et al., 2015; Italian Ministry of Agriculture, Food and Forestry, 2010). The choice of complementarities between strategies in grassland-based systems and adequate feeding strategies aimed to mitigate GHG emissions may result in better environmental advantages (Morel et al., 2016). Finally, it can be highlighted it is crucial to develop strategies to balance the increasing productivity with the environmental sustainability of cattle production (Ogino et al., 2016).

3. Livestock sector in Italy

The livestock sector plays an important role in the Italian agro-food economy. According to the last agricultural census in Italy

there are 124,210.00 bovines' farms, with an average size equal to 45.0 bovines per farm (AgriISTAT, 2010 available at http://www.istat.it/en/agriculture). In the last 10 years the livestock farms number have decreased by 41.3%, those with cattle by 27.8%, while those with dairy cows by 37.0% (INEA, 2014 http://dspace.crea.gov.it/handle/inea/1170). As regards dimension, farms with an Utilized Agricultural Area (UAA) less than 30 ha account more than 76.0% of total bovine farms; those with an UAA higher than 50.0 ha are equal to 5.0%; farms with an UAA higher than 100 ha are 2.4%. According to RICA database, the number of Italian bovines is equal to 5,592,700.00. The main Italian regions in which cattle farming is more concentrated are: Lombardia, Piemonte, Veneto and Emilia-Romagna, where 39.0% of farms holds 64.0% of the bovines (Fig. 1).

In these areas in fact, the soil and climate condition lead crops cultivation for animal feed. Furthermore, the geographical position facilitates the connection with supply and markets, the availability of transport infrastructure and processing industries. As shown in Table 1 number of heads in Veneto is 756,198.00 following by Piemonte (815,613.00), Lombardia (1,484,991.00) and Emilia Romagna (557,231.00), with a significative percentage of dairy production (RICA, 2014 available at http://www.rica.inea.it/public/it/presentazione.php).

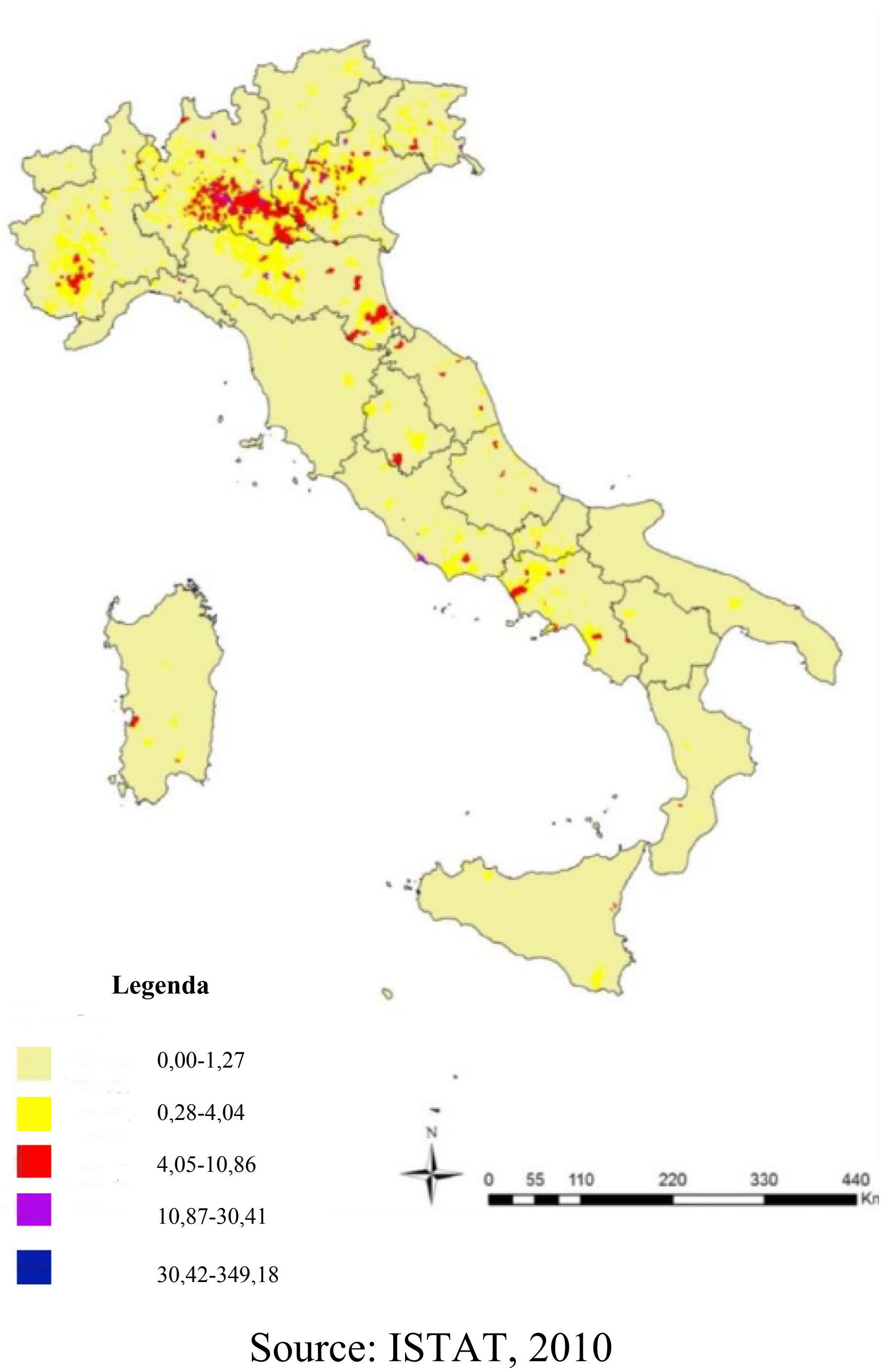

Fig. 1. Number of heads on utilized agricultural area (UAA) in Italy.
Source: ISTAT, 2010 available at http://www.istat.it/en/agriculture.

Table 1
Livestock analysis in the most productive regions.

Regions	Bovine farm's number	Number of heads	Average number of bovines per farm
Piemonte	13,234.00	815,613.00	61.60
Lombardia	14,718.00	1,484,991.00	100.90
Veneto	12,896.00	756,198.00	58.60
Emilia Romagna	7357.00	557,231.00	75.70
Others	76,005.00	1,978,667.00	26.00
Italy	124,210.00	5,592,700.00	45.00

Source: own processing on AgriISTAT (2010) available at http://www.istat.it/en/agriculture and RICA (2014) data available at http://www.rica.inea.it/public/it/presentazione.php.

In the last years a new tendency, has characterized livestock sector: technical management changing. This evolution has been moved by three main drivers:

- innovation in farm building and an increased automation in the livestock work management in order to keep clean farm environments, to guarantee animal health and wellbeing, to increase work efficiency and to reduce management costs;
- reduction of environmental burdens associated to livestock: the rational use of resources, pollution reduction, combining in the best way land farming and landscape;
- working condition improvement in order to guarantee more safety and comfort for the operators.

According to AgriISTAT (2010), available at http://www.istat.it/en/agriculture the Italian milk production value accounted 5690.00 million euro. The number of heads is equal to 1831.00 million (dairy bovines). The average price of milk in stable was equal to 396.4 euro $tonn^{-1}$.

In the same year, the Italian beef production value was equal to 6,946,000.00 tons of carcass, with 2,511,800.0 heads. The Italian production system, based on fattening of specialized slaughter breeds, was strongly dependent on imported weanlings from France, with more than 70% of imports (850,000.0 heads) (AgriISTAT, 2010 available at http://www.istat.it/en/agriculture).

4. Material and methods

4.1. Data

The analyzed sector by the present study belongs to 0141 'Raising of dairy cattle' of the Statistical classification of economic activities in the European Community, abbreviated as NACE (Nomenclature statistique des Activités économiques dans la Communauté Européenne). Identification of research field and initial data collection preceded the investigation phase. Data collection derives from AIDA Bureau van Dijk International Database containing comprehensive information on companies, for individual countries and regions. The AIDA database let out data from 114 mixed cattle farms randomly drawn belonging to 4 Italian regions: Piemonte, Veneto, Emilia Romagna, Lombardia on 21 total regions and 20 cattle farms randomly drawn by remaining regions (where it is less strong the presence of cattle farms). The 20 cattle farms are included in "other regions" group accounting 134 cattle farms in the final sample. Indeed the choice about the regions to be selected is corroborated by previous analysis of the sector: more than half of the cattle farming raised in Italy is concentrated in selected four regions - Lombardia, Piemonte, Veneto and Emilia-Romagna - where 39.0% of companies holds 64.0% of the animals (INEA, 2014 http://dspace.crea.gov.it/handle/inea/1170; Boccaletti and Moro, 2012).

Data concern the performance indicators that estimate the success of a firm and indicate how effectively business objectives are achieved. They are as follows: Revenues from sales and services, Economic Assets, Land and buildings, Research and development and Total shareholder's funds where:

- 'Revenues from sales' is the returns that a firm has from the sale of goods and services to customers;
- 'Economic assets' represents any item of economic importance functioning as store of value in a firm;
- 'Land and buildings' comprises all land and buildings located within an economy - 'Research and development' (R&D) refers to the research activities aimed to improve existing products, processes and procedures or to develop new products, processes and procedures.
- 'Shareholders' funds' is the value of shareholders' investment in a particular firm.

The choice of the above mentioned indicators for assessing the firm performance is corroborated by several research and scientific reports; the European System of National and Regional Accounts and some scholars (ESA, 2013; Arimany-Serrat et al., 2016; Fuentes-Lombardo et al., 2014) define the economic asset such as an indicator of carrying forward value from one accounting period to another, by assessing the firm economic performance. Other studies offer evidence of the effect of revenues from sales on firm performance and the role of the shareholders' funds on the corporate governance (Thomé et al., 2012; OECD, 2004). In addition, the impact of R&D area on the firm productivity has been investigated by several authors (Acosta et al., 2015; Aw et al., 2008).

The performance indicators are in thousand Euros and referred to 2014 year. As regard the other selected variables, we have the average emission intensities that are 1.5 kg CO_{2eq} per kg of fat and protein corrected milk (milk is normalized in fat and protein corrected milk, to account for the heterogeneity in milk production) for milk and 11 kg CO_{2eq} per kg of live weight per year for beef (Gerber et al., 2013). Considering the annual average production of a dairy cows equal to 8295.8 kg·per year, therefore total emissions per year are equal to 12443.7 kg CO_{2eq}·per year (ANAFI, 2016 available at http://www.anafi.it/).

Considering the annual average increased body weight of beef equal to 320.0 kg·per year (ANABIC, 2016 available at http://www.anabic.it/frame-destra.htm), the total emissions are equal to 3520 kg CO_{2eq}·per year^{-}ISMEA,2014 available at http://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/4486?YY=2014 (Table 2).

According to the following equation, the mean cattle emissions are equal to 7981.85 CO_2 eq that is as follows:

$$\text{Emission mean} = (\text{emission dairy cattle} + \text{emission beef cattle}): 2$$

that is:

Table 2
Average emissions for milk and beef production.

	Average emission intensities ($kg\ CO_{2eq}\ kg^{-1}$) (Gerber et al., 2013)	Annual average production ($kg\ CO_{2eq}\ y^{-1}$) (ANAFI, 2016; ISMEA, 2014)	Annual average emissions ($kg\ CO_{2eq}\ y^{-1}$) (Our elaboration)
Milk production	1.50	8295.80	12,443.70
Beef production	11.00	320.00	3520.00

Source: own processing.

(12,443.7 CO_2 eq +3520.0.0 CO_2 eq): 2 = 7981.85 CO_2 eq

According to AgriISTAT data in 2010 available at http://www.istat.it/en/agriculture the farm's average emission was calculated by multiplying the average emission for cattle by the average number of animals in the region (Table 3).

The data analysis has been performed by following an integrated statistical approach consisting in two steps:

1) Verifying the possibility to classify the Farm emission respect to the predictor variables (Assets, Revenues from sales and services) by means of CHAID decision-tree algorithm. In particular, a CHAID decision-tree algorithm with a splitting criterion based on a chi-square test has been used (Magidson, 1994) and a confirmatory analysis with cross-validation that divides the sample into 10 subsamples. Tree models was then generated by excluding from time to time data from each subsample. The first tree was based on all cases except those contained in the first sample, the second tree was based on all cases except those contained in the second sample, and so on. Cross validation had produced a single, final tree model.
2) consequently, a two-stage method of clustering like BIRCH (Zhang et al., 1996), based on the hierarchical method, was applied to identify segments of farms who showed similar values for economics variables, in order to show the differences between farms groups and to connect the economics characteristics of the farms with the emission. The cluster analysis was applied only to farms without missing. Data analysis has been performed using the SPSS 20.0.

5. Results and discussion

The descriptive statistics of the performance variables are shown in Table 4. Further exploratory analysis of the variables contained in the profitable Aida data base showed considerable variability of the same, especially for Revenues from sales and services (coefficient of variation equal to 2.05 and coefficient of asymmetry equal to 5.28). Assets variable showed instead less variability than Revenues from sales and services variable (coefficient of variation equal to 1.28 and coefficient of asymmetry equal to 2.94). The variable Land and buildings has unfortunately shown a high proportion of missing data (47.7%).

Table 3
Average number of animals per farm and per Region and Farm emission mean (kg CO_{2eq} · per year).

Region	Average number of animals per farm (ISTAT, 2010)	Farm emissions mean (kg CO_{2eq} per year)
Piemonte	61.60	491,681.96
Lombardia	100.90	805,368.67
Veneto	58.60	467,736.41
Emilia Romagna	75.70	604,226.05
Other regions	26.00	207,528.10

Source: own processing on AgriISTAT (2010) available at http://www.istat.it/en/agriculture and FAO STAT (2010) data.

5.1. Decision tree

The CHAID tree algorithm allowed to assess the presence of eventually similarities or dissimilarities between groups of cattle farms and provided a criterion of classification of farm-emission by predictor variables (Assets and Revenues from sales and services). The classification trees were formed from the root (the highest node of each tree) until reaching a terminal node or leaf. Then each node of trees shows the predicted value, which is the mean value for the dependent variable at that node. The resulting classification trees for farm emissions are shown in Figs. 2 and 3, respectively by Assets, and Revenues from sales and services as independent variables (total sample n = 134 cattle farms). Also the other predictor variables were included in the model, but the latter were excluded by tree algorithm because not significant.

Even interaction between Assets and Revenues from sales and services was not found significant for the purposes of emissions cattle farms classification, for this two separate decisional tree were generated.

By analysis of results (Figs. 2 and 3), it can be seen that both trees have two child nodes suggesting the presence of two groups and that the detected portions were all statistically significant (p-value <0.005 by Assets and $p < 0.05$ by Revenues from sales and services).

As shown by Fig. 2 considering Assets as predictor variable there are two groups of classification for farm emissions: the cut-off is 2970.0 Euro. For Assets value $\leq$ 2970.0 Euro, the tree algorithm detected a homogeneous group of n = 53 cattle farms with Farm emission mean equal to 494,961.43CO_2 eq. Whereas for Assets value > 2970.0 Euro, there is second homogeneous group of n = 81 with Farm emission mean equal to 599,513.02CO_2 eq. Both groups are characterized by considerable internal variability probably due to the different regional intra firm size. There is literature dealing with the correlation of the size of the farm (whose assets belong) with the economic performances, discussing the concept of economies of scale (Jaforullah and Whiteman, 1999; Morrison et al., 1999): indeed, some results also suggest that farming is characterized by constant returns to scale (Jaforullah and Whiteman, 1999). The idea that size bring economic and environmental economies of scale and scope in cattle production systems (Veysset et al., 2014). This emphasizes the importance of appropriately representing substitution relationships for measuring scale and external effects.

These results are as expected at the theoretical level and considering the assets derivate from earnings and produce revenues from sales of products; the GHG emissions increase with the increase of the production amount, if the farm management does not reach high production efficiency (Podkówka et al., 2015; Italian Ministry of Agriculture, Food and Forestry, 2014). From this, it can be derived Italian cattle firm do not seems in average to have good productivity performance.

Considering Revenues from sales and services (Fig. 3), as predictor variable, there are two groups of classification for Farm emissions: the cut-off is 2773.0 Euro. For revenues from sales and

Table 4
Descriptive Statistics of performance variables.

	N	Minimum	Maximum	Mean	Std. Deviation
Revenues from sales and services	134	284,00	86.752,00	5.327,4627	10.912,97,251
Assets	134	369,00	46.573,00	6.679,2463	8.557,22,388
Research and dev. (R&D)	91	0,00	82,00	1,1319	8,75,748
Land and buildings	70	0,00	26.980,00	2.473,5571	4.901,64,032
Shareholder's funds	134	−919,00	19.480,00	1.437,2239	2.861,53,598

Source: our processing.

services value ≤ 2773.00 Euro, the tree algorithm detected a homogeneous group of n = 80 cattle farms with Farm emission mean equal to 463,353.57CO_2 eq. Whereas for Revenues from sales and services value > 2773.0 Euro there is a second homogeneous group of n = 54 with Farm emission mean equal to 585,344.17CO_2 eq. Also in this case the two groups are characterized by a considerable internal variability probably due to the different regional intra dairy farm size. These results are in line with the previous results related to the assets.

5.2. Cluster analysis

The cluster analysis was applied only to cattle farms without missing data (52.2% of the entire sample). In order to improve our data analysis and to reach our research aims, the Research and development variable was added in the cluster analysis to give evidence if the R&D area can play a crucial role in identifying segments of farms who showed similar values for economics variables. Three clusters were derived using a two-stage method of clustering like BIRCH (Zhang et al., 1996). The size and characteristics of each cluster are showed in Fig. 4, and the variables were listed according to the decreasing predictive importance in the cluster formation, thus giving the Assets as the most important variable. Cluster 1 is composed by 46.4% of the cattle farms (n = 32), cluster 2 collects 11.6% of the cattle farms (n = 8) and cluster 3 collects 42.0% of the cattle farms (n = 29).

Farms belonging to cluster 3 have an Assets mean equal to 3694.9 Euro, Farm Emission mean equal to 394,550.82CO_2 eq and Total shareholder's funds mean equal to 600.3 Euro, while cattle farms belonging to Cluster 1 are characterized for all listed variables by higher average values with respect to cluster 3 (Assets mean equal to 6352.5 Euro; Farm emission mean equal to 394,393.43CO_2 eq.; Total shareholder's funds mean equal to 1211.9 Euro).

In the third segment, the 59.4% of the cattle farms belong to the Veneto region, while in the third cluster there is a prevalence of cattle farms of Emilia Romagna (55.2%). Then it can be highlighted that the farm emissions are higher into cluster 1 than respect to the cluster 3, in correspondence with the increase of the average values

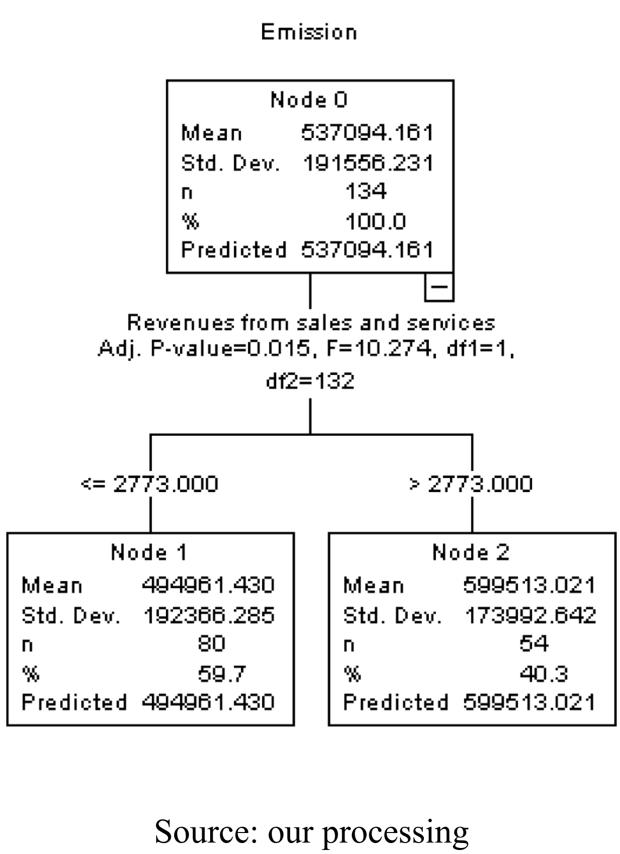

Fig. 2. Classification tree of Farm emissions by Assets.
Source: our processing.

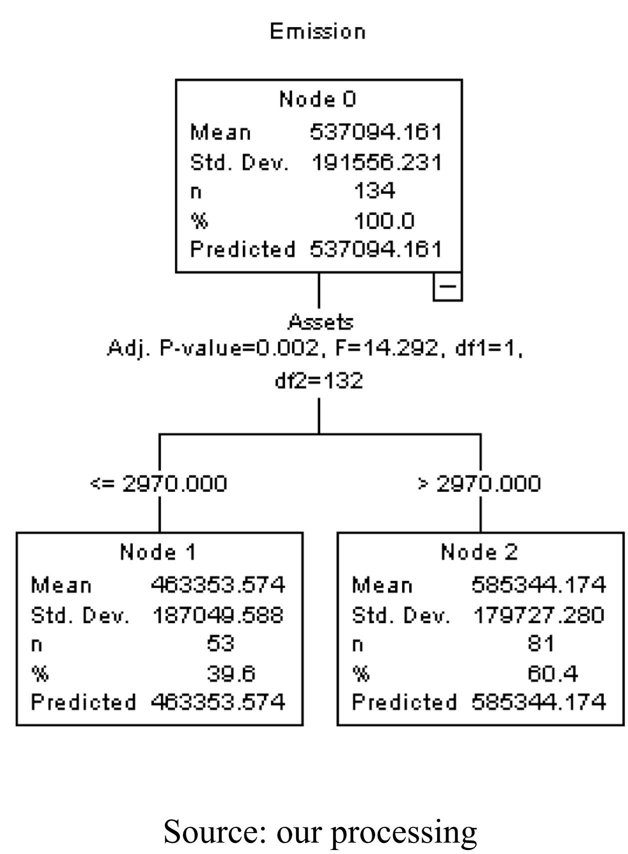

Fig. 3. Classification tree of Farm emissions by Revenues from sales and service.
Source: our processing.

of economic performance variables. The second segment has an anomalous and special appearance, since the average values of economic characteristics are even higher (Land and buildings, Total shareholder's funds, and revenues from sales and services), but we are witnessing a reversal of the average emissions of farm cattle that are equal to 537,056.05CO_2 eq. So this cluster was labeled Virtuous farm's cluster since the latter amount of emissions corresponds the higher value of the Assets (and respectively of the Land and Buildings value). In order to highlight this insight, Table 5 shows the ratio between Assets and emissions in the 3 clusters that completely varies (Table 5); so in the second 'virtuous' cluster, we have a value of emissions 'pro asset unit' equal to 17 while cluster 1

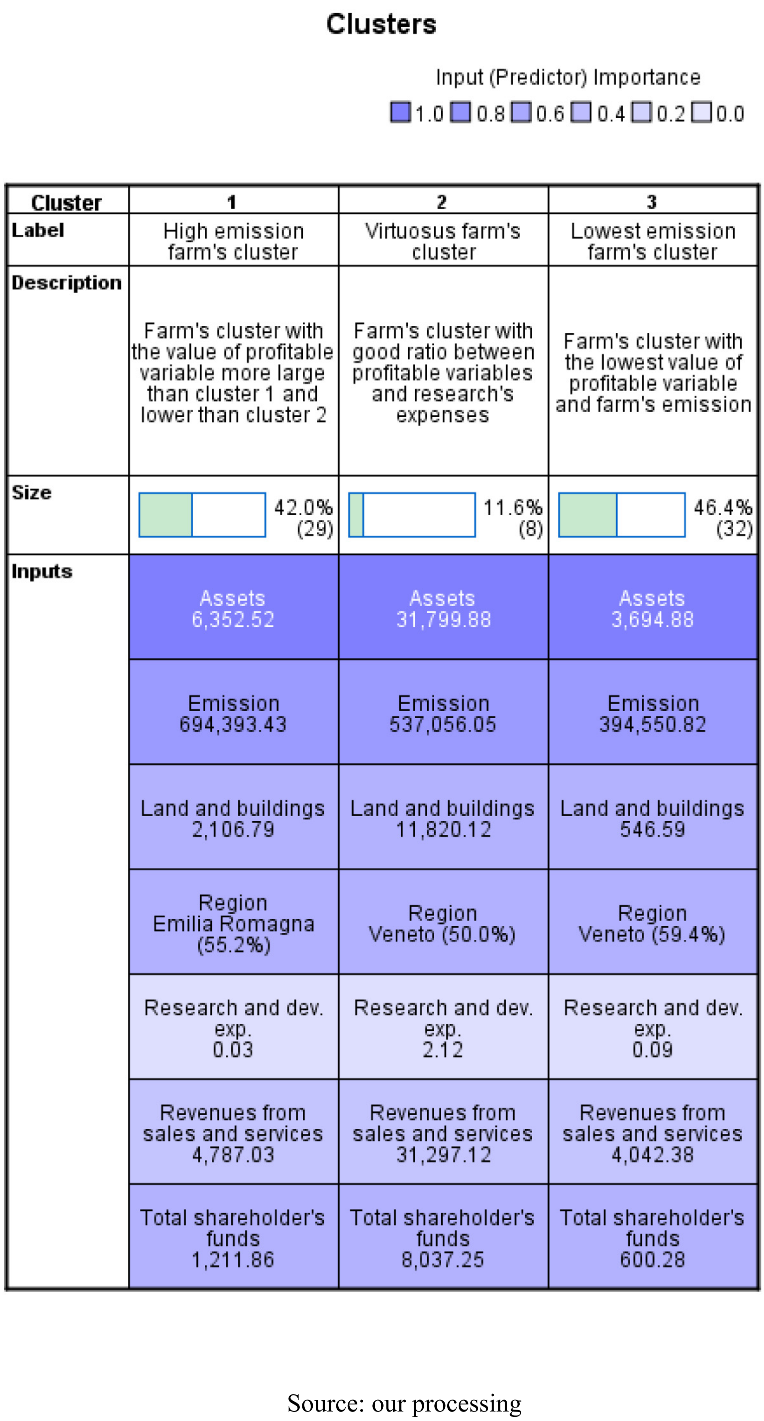

Fig. 4. Profiles of cattle farm's cluster.
Source: our processing.

Table 5
The ratio between economic assets and emissions in 3 clusters.

	Cluster 1	Cluster 2	Cluster 3
Farm Emissions	694,393.43CO_2 eq.	537,056.05 CO_2 eq.	394,550.82 CO_2 eq.
Total Assets	6353 €	31,800 €	3695 €
Emissions pro Asset	109.30	16.88	106.78

Source: our processing.

and cluster reach approximately the same value equal to 110. Subsequently the cluster 3 and 2 show proportionality and give evidence of the perfect link between Farm Emissions and Assets.

Therefore, the best performance of the second cluster can depend on two concerns:

1. The role that assumes the R&D variable (that show a value certainly higher than the one of the cluster 3 and 1), and
2. The greater dynamism of the dairy farms of the North Italy area, in special way of the Veneto region divided into 2 typology of farm and respectively two complementary trends.

The third collects the small farms sector, often located in marginal areas, which cannot provide a qualitative and sustainable enhancement of the production. The second one, that could represent the more virtuous, collects farms that have decided to reach and to defend the farm's profitability and efficiency in the new competitive scenarios. Furthermore, the scenario in EU of the cattle sector is plagued by the Fischer reform that reduces and decreases the guaranteed role of the intervention price together the abolition in 2015 of the production quota system in the milk sector (Boccaletti and Moro, 2012).

In order to face these challenges, a crucial role can be covered by the Research & develop firm area aimed at improving of the production systems; as a matter of fact the cluster 1 shows a value of the R&D expenses higher than cluster 3 and 2. From this emerges the great importance that the research activities can have in improving firm management, so reducing the emissions. Several strategies at national and international level are crucial for addressing a bioeconomy pathways aimed to efficient use of the resources.

6. Conclusions

In order to reduce the environmental and economic impacts, a resource use efficiency along the whole supply chain and mitigation interventions are needed. Findings showed that the GHG emissions increase with the increase of the production amount, so highlighting not-efficient cattle farms produce a huge higher amount of emissions (Podkówka et al., 2015). Virtuous cattle farms present a lower amount of emissions that corresponds to the higher value of the Assets deriving from an efficient resources management.

There is literature dealing with the correlation of the size of the farm (and assets contribute to the size) with the better economic performances, discussing the concept of economies of scale (Jaforullah and Whiteman, 1999; Morrison et al., 1999). Here, the idea the size brings economic and environmental economies of scale and scope in cattle production systems stands out (Veysset et al., 2014).

Thus, the farming sector has to adopt low emission practices and efficient techniques: agricultural practices that preserve the soil fertility, increase the organic matter content and sequester atmospheric carbon. Furthermore, a better management of health and animal welfare, can reduce unproductive shares of the cattle (FAO, 2011). Know how transfer and research and development activities in the cattle farming might improve sustainability and efficiency (Paracchini et al., 2015). Reduction strategies can be managed and handled at different levels: at animal level, at herd level, at production unit level, at supply chain level (Gerber et al., 2013). Small ruminants can produce also important co-products including wool, cashmere and mohair. It is to be highlighted, therefore, a substantial share of emissions, in areas important for natural fiber production, can be attributed to these products, reducing the share of emissions attributed to milk and meat production (ibidem).

To move forward a competitive and sustainable bio-economy, it seems crucial pay attention on two important themes: participatory governance that engages key stakeholders in an shared dialogue as well as a commitment by government and industry to innovation that drives efforts on sustainable development of the bioeconomy (McCormick and Kautto, 2013).

Regarding research limitations of the present work, it can be highlighted the sample size could be expanded to include cattle farming from other countries. Far from being exhaustive, this paper can shed some light on this topic, since there are few studies regarding the link between GHG emissions associated cattle production and economic performances. Reducing GHG emissions and correlatively reaching best economic efficiency performance by means of available practices that improve production efficiency in the cattle farming could have important economic, social and generational implications because livestock is among the major economic activities in Italy and not only; in addition, it can have a crucial role for improving local communities and so competitiveness in the farming sector.

Finally, it is necessary to undertake an holistic, responsible bioeconomy for sustainable production and consumption of quality and sustainable products in various fields of the economy, for today and the future.

Research macro-areas

Agro-ecosystem and environmental impacts such as, for instance, GHG emission, water and fossil fuel consumption, soil contamination and air pollution, land use.

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